Substation automation
Lowering substation retrofit cost with wireless communication

As with all smart grid applications, two-way communication is foundational to substation automation. To enable monitoring and control, substation computers, and computers in utility operations centers, must exchange information with intelligent electronic devices (IEDs) throughout the substation yard.

Benefits
• Improve reliability and efficiency of power delivery
• Lower operating costs by reducing truck rolls
• Improve response times and visibility through remote troubleshooting
• Leverage communication network for applications beyond automation, e.g., site security

ABB Wireless Technology Differentiators
• Broadband networks provide a high bandwidth, low latency communication foundation for substation automation
• Wireless networks eliminate trenching costs associated with wired communications
• Wireless networks shorten deployment timelines and make them more predictable
• TropOS broadband wireless mesh networks provide high reliability, enterprise-class security and multi-use capability
• TropOS mesh routers are IEEE 1613 approved, support DNP3, Modbus and IEC 61850, and provide the technical controls required for a utility to achieve NERC CIP v5 compliance.

For new substations, both wired and wireless communications are options because the incremental cost of trenching to run cabling from the control house to IEDs in the yard is minimal. Construction equipment is already onsite and the grounding and surface of the yard has not yet been finalized.

However, adding new IEDs to existing substations is a different story. The cost of wired solutions is often prohibitive, due largely to the expense of trenching. Wireless communication, which requires no trenching, is almost always the more cost-effective way to install a network during a substation retrofit.

Substation automation: a key piece of grid modernization
Substation automation applications are a key element in a utility’s smart grid portfolio. Intelligent electronic devices (IEDs) – including breaker controllers, voltage regulators and remote terminal units (RTUs) – deployed throughout the substation can gather data and take action to, say, distribute power more efficiently or protect the power delivery infrastructure. Analyzing data and issuing commands is the responsibility of substation computers and/or computers located in the utility’s operations center. For the system to work, two-way communication between IEDs and substation computers as well as data center computers is required. By automatically configuring substation systems for safe, efficient electricity delivery, substation automation saves money while improving grid reliability. Since action can be taken remotely, truck rolls are reduced, saving
money while enhancing safety because workers are dispatched to remote locations less frequently.

**Wireless communication for substation automation**

For new substations, both wired and wireless communications are options. During construction, trenching equipment is already onsite and the yard’s surface has not been installed. The incremental cost of trenching to run cabling from the control house to IEDs in the yard is minimal, removing the biggest obstacle to employing a wired network. While wireless still has advantages, e.g., enabling network access for workers at the substation, wireless does not have a huge economic edge over wired options.

However, modernizing existing substations is a different story. The cost of wired solutions is often prohibitive, due to trenching expenses. Wireless communication, which requires no trenching, offers more cost-effective network installation during a substation retrofit and usually by a wide margin.

ABB civil engineers have estimated that trenching costs to retrofit an existing substation yard with wired communications are typically in the range of $40,000 to $45,000, with costs of $100,000 to $150,000 possible for larger or more challenging installations. The civil engineers may have been too conservative. One utility recently reported that it spent in excess of $250,000 digging trenches to wire three IEDs in an existing substation.

In addition, using wireless shortens deployment timelines and makes them more predictable. It is faster to deploy wireless than it is to engage a contractor to dig, lay conduit, run cables, etc. Eliminating trenching removes a dependency that could delay the project if, say, the contractor’s previous job runs longer than expected.

When a utility’s service territory crosses political or jurisdictional boundaries, different laws, regulations, contractors, union rules, etc., may be applicable to trenching. With wireless, none of this comes into play. Utilities will have fewer operational surprises, lower costs and easier deployment of automation projects.

Wireless also makes the substation future ready. Trenching and pulling cable provides wiring only to poles and assets in place or planned today. What if, in the future, additional poles, IEDs, etc., are required? Time to dig down to the conduit and go to work.

ABB Wireless mesh networks provide the high throughput, low latency and reliability required to support virtually any substation automation application that can be supported by a wired network. (An important exception is protection applications that require ultra-low latency (<1 ms) and that cannot be supported by any form of packetized data network, whether wired or wireless.) TropOS mesh routers provide Ethernet and serial connections to attach IEDs without native wireless interfaces, support popular utility automation protocols including DNP3 and IEC 61850, provide the technical controls required for a utility to conform NERC CIP v5, and are specially hardened for substation operation (IEEE 1613).

**Enabling additional applications using substation automation networks**

Another advantage of TropOS wireless broadband mesh networks is that they can enable substation applications beyond automation. For example, substation security can be enhanced by leveraging the wireless network to support video surveillance cameras and intrusion sensors. Unscheduled maintenance can be reduced by using the wireless network to monitor smart transformers or gas sensors mounted near conventional transformers.

The productivity of mobile workers at substations is increased because they can use their laptops and handhelds to remotely access information that would be available to them at the operations center, to file reports from the field and to access work orders in the field. In areas lacking cellular coverage, worker safety is enhanced by providing a voice over IP (VoIP) lifeline using a laptop or handheld.

In addition to performance, features of TropOS mesh networks that make them well-suited to support multiple applications include virtual LANs (VLANs) and quality of service (QoS). Each application can be supported on a separate VLAN configured with appropriate QoS settings. Using these capabilities, a utility can ensure latency-sensitive applications get access priority over other applications with less stringent latency requirements.

**Substation automation building blocks**

The basic building blocks for substation automation include IEDs, substation computers, data center computers, their associated software and a communication network. Additional substation applications can be enabled using smart transformers and/or transformer gas sensors, video cameras and digital video recorders, and intrusion sensors, as well as by equipping field workers with laptops, tablets or handhelds.

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